

REMARKS

After entry of this Amendment, claims 1, 3–5, 7–6, and 11–16 will be pending; claims 3–5 and 11–13 have been withdrawn in response to a restriction requirement, and claims 2, 9, and 10 are cancelled. Claim 15 has been rewritten in independent form, and claim 14 has been amended to depend on claim 15. No new matter has been added.

Rejection of claims under 35 U.S.C. § 112

Claim 7 is rejected under 35 U.S.C. § 112, second paragraph. Applicants submit this rejection is moot, in view of the amendment of claim 7 to depend on claim 1 rather than on cancelled claim 6.

Rejection of Claims Under 35 U.S.C. 103(a)

Claims 1 and 9 are rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 5,198,269 to Swartz et al. (“Swartz”) in view of Rehrig et al., “Piezoelectric properties of zirconium-doped barium titanate single crystals grown by templated grain growth,” *Journal of Applied Physics*, Vol. 86, No. 2, August 1, 1999, pages 1657–1661 (“Rehrig”). The rejection of claim 9 is moot in view of the cancellation of that claim.

The examiner appears to consider the first sol-gel perovskite layer of Swartz to be an optical buffer layer, equivalent to the optical buffer layer recited in claim 1. The first sol-gel perovskite layer disclosed by Swartz, however, is not an optical buffer layer. It is provided to enable the formation of a second perovskite layer with better crystallinity, and which crystallizes at a lower temperature and/or with shorter times. Indeed, given their high indices of refraction, the recommended layers “selected to produce [upon heat treatment] a perovskite of: lead titanate (PbTiO₃), or strontium titanate (SrTiO₃)” would not serve as optical buffer layers, i.e., would not confine the light within the modified barium titanate. *See* column 3, line 41 – column 4, line 7.

The examiner correctly states that buffer layer are commonly grown on substrates to enable better formation of additional layers thereon. The buffer layer recited in claim 1, however, is actually an optical buffer layer. As is known to one of skill in the art, optical buffer

layers are required in optical structures formed over silicon to prevent light loss into the underlying silicon. Such optical buffer layers are not taught or suggested by the cited prior art.

The examiner concedes that Swartz does not disclose modified barium titanate comprising 2 to 20 mol% of Zr (BaZrO_3), as recited in independent claim 1, and relies on Rehrig to teach thin films including these compositions. Rehrig, however, does not teach or suggest the formation of thin films including modified barium titanate. Rather, Rehrig discloses the formation of single crystals. One of skill in the art would find no motivation in the cited references to substitute the barium titanate thin film of Swartz formed from a sol-gel precursor with the single crystal of Rehrig formed by templated grain growth. The single crystal grown by Rehrig is not compatible with the sol-gel process of Swartz used for the formation of thin films. Moreover, even if one were to somehow combine the barium titanate single crystal of Rehrig with the structure of Swartz, one still would not obtain the modified barium titanate thin film recited in amended independent claims 1 and 9. Rather, one would have a modified barium titanate single crystal disposed on a substrate, and not a thin film.

The examiner stresses that Rehrig is relied on only to teach a particular composition of barium titanate doped with zirconium. Rehrig discloses this composition as having desirable piezoelectric properties. *See* page 1657, second column, first and second paragraphs. *See* page 1657, first column, first and second paragraphs. Rehrig is silent regarding the optical properties of this material. Moreover, Swartz suggests only barium titanate or barium strontium titanate for use in optical waveguide devices. *See* column 19, lines 53–55. One of skill in the art would find no motivation in the cited art to substitute the Zr-doped barium titanate material of Rehrig for the barium titanate or barium strontium titanate material suggested by Swartz for the formation of optical waveguide devices, to obtain the optical structure recited in independent claim 1.

Applicants submit that for at least these reasons, claim 1 and claims dependent therefrom are patentable.

Claims 1, 7–9, and 14–16 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,103,008 to McKee et al. (“McKee”) in view of Rehrig. The rejection of claim 9 is moot in view of the cancellation of that claim.

McKee appears to disclose a structure including a thin film of the perovskite BaTiO_3 , as well as the formation of such structure. In some embodiments, Zr or Hf may be substituted on the A site for barium in ABO_3 material. *See* column 2, line 59 – column 3, line 3. McKee does not teach or suggest a structure including barium titanate in which Ti is substituted with Zr on the B site, i.e., modified barium titanate comprising barium titanate including 2 to 20 mol% of Zr (BaZrO_3), as recited in amended independent claim 1. McKee also does not teach or suggest forming such structure, as recited in amended independent claim 15.

The Examiner asserts that the instant claims do not recite barium titanate in which Ti is substituted with Zr on the B site. Applicants respectfully disagree. Independent claims 1 and 15 recite modified barium titanate including $\text{Zr}(\text{BaZrO}_3)$. “ BaZrO_3 ” is the symbol for an ABO_3 material in which Ba is on the A site and Zr is on the B site (rather than on the A site, as taught by McKee).

The examiner concedes that McKee does not disclose modified barium titanate comprising 2 to 20 mol% of Zr (BaZrO_3), as recited in claims 1 and 15, and relies on Rehrig to teach thin films including these compositions. Rehrig discloses the formation of single crystals of $\text{Ba}(\text{Zr}_x\text{Ti}_{1-x})\text{O}_3$ for sensor and actuator applications. *See* abstract and page 1657, first column, first paragraph and second column, second paragraph. Rehrig does not teach or suggest the formation of thin films including modified barium titanate. Rather, Rehrig discloses the formation of single crystals. One of skill in the art would find no motivation in the cited references to substitute the barium titanate thin film of McKee intended for electro-optical applications with the single crystal of Rehrig intended for sensor and actuator applications. The teachings of these two references are not combinable because the formation of bulk single crystals by templated grain growth, as taught by Rehrig, is inconsistent with the formation of thin films on semiconductor substrates by, e.g., epitaxy, as taught by McKee. Moreover, even if one

were to somehow combine the barium titanate single crystal of Rehrig with the structure of McKee, one still would not obtain the modified barium titanate thin film recited in amended independent claims 1 and 15. Rather, one would have a modified barium titanate single crystal disposed on a substrate, and not a thin film. Neither reference, alone or in combination, teaches a modified barium titanate thin film comprising barium titanate including 2 to 20 mol% of $\text{Zr}(\text{BaZrO}_3)$.

The examiner stresses that Rehrig is relied on only to teach a particular composition of barium titanate doped with zirconium. Rehrig discloses this composition as having desirable piezoelectric properties. *See* page 1657, second column, first and second paragraphs. Rehrig is silent regarding the optical properties of this material. One of skill in the art would find no motivation in the cited art to substitute the Zr-doped barium titanate material of Rehrig for the material suggested by McKee for the formation of electro-optic devices, to obtain the optical structure recited in independent claim 1 or to form such structure as recited in independent claim 15.

Applicants submit that for at least these reasons, claims 1 and 15 and claims dependent therefrom are patentable.

In summary, Applicants admit that the stabilization of barium titanate by the use of zirconium is known in the art. Applicants, however, have made the surprising discovery that modified barium titanate including zirconium is useful in optical devices, based in part on its low dielectric constant and high electro-optic coefficient. *See* specification, page 4, lines 1 – 7. The cited prior art, either alone or in combination, does not teach or suggest the optical device recited in independent claim 1, or a method for making such device, as recited in independent claim 15.

CONCLUSION

In light of the foregoing, Applicants respectfully submit that all claims are now in condition for allowance.

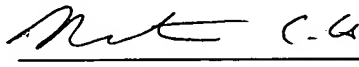
If the Examiner believes that a telephone conversation with Applicants' attorney would expedite allowance of this application, the Examiner is cordially invited to call the undersigned attorney at (617) 570-1806.

Applicants believe that no fee is due for filing of this amendment. However, if any additional fee is due, please charge said fee occasioned by this paper to our Deposit Account No. 07-1700.

Respectfully submitted,

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